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European Microkelvin Collaboration

CAPACITIES

Report on the Transnational Access Activity carried out within MICROKELVIN

The eligibility of transnational access to a MICROKELVIN TA site implies the submission of the following:

1) The Certification of visit

The form "Certification of visit" must be completed and signed by the access provider in charge of the infrastructure and the leader of the project.

2) A TA project report

The form for the TA project report is contained within this document. It should be completed after project end by the group leader of the project. You must respect the limited number of words specified, longer descriptions will be rejected. Figures/tables may be attached at the end of the document. The document must be submitted in an editable format (doc, rtf).

3) A User group questionnaire

To enable the Commission to evaluate the Research Infrastructures Action, to monitor the individual contracts, and to improve the services provided to the scientific community, each project leader of a user-project supported under an EC Research Infrastructure contract is requested to complete a "user group questionnaire". The questionnaire must be submitted once by each user group to the Commission as soon as the experiments on the infrastructure come to end.

The user group questionnaire is not part of this document and must be completed on-line. It is accessible at:

http://cordis.europa.eu/fp7/capacities/questionnaire_en.html.

► **Please note that any publications resulting from work carried out under the MICROKELVIN TA activity must acknowledge the support of the European Community:**

> **"The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 228464 (MICROKELVIN)."**

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MICROKELVIN Transnational Access Project Report

1. General information

Project number:	**AALTO34**	
Project Title:	**Noise in quantum phase slip superconducting nanowires**	
Lead scientist:[1]	**Title:**	Dr.
	First name:	Konstantin
	Last name:	Arutyunov
	Home institution:	University of Jyväskylä
Host scientist:[2]	**Title:**	Prof.
	First name:	Pertti
	Last name:	Hakonen
	Home institution:	Aalto University
Project scientist:[3]	**Title:**	Dr.
	First name:	Konstantin
	Last name:	Arutyunov
	Birth date:	1962-03-12
	Passport number:	
	Research status/Position:	Senior Researcher
	New User:[4]	YES
	Scientific Field:	Mesoscipic superconductivity
	Home institution:	University of Jyväskylä
	Is your home institution MICROKELVIN partner?	No
	Business address:	University of Jyväskylä, Dept. of Physics, NanoCentre
	Street:	Survontie 9
	PO Box:	35
	City:	Jyväskylä
	Zip/Postal Code:	40014
	Country:	Finland
	Telephone:	358408054061
	Fax:	358142602351
	E-mail:	konstantin.yu.arutyunov@jyu.fi

[1] The lead scientist indicated here is expected to participate in the campaign as a user of the infrastructure.

[2] The host scientist is supervising the work of the visiting project scientist at the infrastructure.

[3] The project scientist is the person who will be visiting the infrastructure.

[4] Indicate 'Yes' only if the user has never visited the infrastructure before this specific project, otherwise write 'No'.

2. Project information

Please, give a brief description of project objectives: (250 words max)	The goal is to perform an experimental study of noise spectra from quantum fluctuations in nanoscale superconductors. This subject is of multidisciplinary nature, it requires state-of-the-art nanofabrication, advanced materials science, ultra-low temperatures and microwave techniques, as well as complex theoretical analysis. Shot noise contains information on electronic transport properties that cannot be obtained by simple conductance measurements. Given that a phase slip event is identical to tunneling, it is reasonable to assume that it should provide a certain contribution to the noise spectrum. To the best of our knowledge, a model describing excess noise in quantum-phase-slip (QPS) governed nanowires has not been introduced so far. The goal of the project is to demonstrate voltage noise due to quantum phase slips in narrow superconducting wires and study their dynamics both in the incoherent and coherent regimes. The objectives correspond to the long-term vision of developing this topic in superconductivity in general and in superconducting nanoelectronics in particular. The results will provide important understanding of the nature of quantum solids and of the very foundations of quantum coherent phenomena.
Technical description of work performed: (250 words max)	The JYU team fabricated nanostructures for the noise experiments: (i) 4-terminal nanostructure with an array of parallel superconducting nanowires in the regime of QPSs; and (ii) hybrid tunnel nanostructures comprising as a central electrode a superconducting loop in the regime of QPS. The first samples were fabricated using standard 'work horse' materials: Al and Ti. In order to enhance impedance matching, we employed 100 wires in parallel. The device geometries were tested in Jyväskylä before shipping the samples for noise measurements to the Low Temperature Laboratory (LTL). The samples were measured at 20 mK and voltage fluctuations in the superconducting state were compared with fluctuations in the normal state. Furthermore, noise in the biased regime was also investigated.
Project achievements (and difficulties encountered)[5]: (250 words max)	The conductance measurements showed similar behaviour in the nanowires as observed in Jyväskylä. This means that the measurement setup at LTL works at sufficiently low external noise levels for detailed studies of phase slips. The voltage fluctuation measurements displayed distinct excess noise in the samples. The excess noise was related with resistance and bias voltage, i.e. with the rate of phase slips. The level of shot noise, however, was quite small, smaller than expected, which indicates that the theoretical understanding should be revised. Comparison with normal state noise demonstrated that the excess noise level is below the normal state shot noise. This is believed to be an indi-

	cation that the noise is not fully white in the superconducting state. For future experiments, a wider bandwidth setup will be constructed that will allow the investigation of the frequency dependence of the excess noise. We also measured the temperature dependent contribution of thermal phase slips (close to the critical temperature Tc) and compared that with the quantum behavior well below Tc. This comparison was complicated by the spread of critical temperatures of the wires. It was concluded that for this part of the work, single wires would be needed for further experiments.
Expected publications and dates:	Pasi Lähteenmäki et al. “Shot noise of Quantum Phase Slips”, 2014
Submission date of user group questionnaire:	30 Sep. 2013

Completed Project Reports should be returned to MICROKELVIN Management Office

(Mari.Kaarni@aalto.fi, Fax: +358 9 47022969).

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CAPACITIES

CERTIFICATION OF VISIT

at MICROKELVIN Transnational Access Site

I herewith confirm that the following project was carried out at our Transnational Access Site

O.V. Lounasmaa Laboratory, Aalto University

in the context of MICROKELVIN Transnational Access:

Noise in quantum phase slip superconducting nanowires

The amount of access[1] delivered to the project group (project users) is as follows:

	Participant name	Duration of stay (start – end date)	Amount of access[2]
Project leader:	Konstantin Arutyunov	02-14.09.2013	13
Project user 1:	Konstantin Arutyunov	10-20.06.2013	11
Project user 2:			
Project user …:[3]			
Total amount of access delivered to project group:		24 days	[redacted]

Otaniemi 23.9.2013

Location and date

Signature of access provider
Pertti Hakonen

Otaniemi 23.9.2013

Location and date

Signature of project leader
Konstantin Arutyunov

Completed Certification of Visit should be returned to MICROKELVIN Management Office
(sari.laitila@aalto.fi, fax: +358 9 47022969)

[1] TKK Helsinki, CNRS Crenoble, or Lancaster University

[2] The amount of access is defined as the time, in days, spent by the user at the infrastructure for this project, including weekends and public holidays (e.g., a scientist who spent 5 days at the infrastructure must indicate '5'). The total amount of access of the project group is the sum of access days of each project user.

[3] Please, expand if necessary.